<International Research Center for Elements Science> Advanced Solid State Chemistry

International Research Center for Elements Science
- Advanced Solid State Chemistry -

http://msk2.kuicr.kyoto-u.ac.jp/

Prof
TAKANO, Mikio
(D Sc)

Assoc Prof
TERASHIMA, Takahito
(D Sc)

Assist Prof
SAITO, Takashi
(D Sc)

Res Associate
YAMAMOTO, Shinpei
(D Eng)

PD
MASUNO, Atsunobu
(D Sc)

Guest Scholar
ARAFAT, Samia
(Ph D)

Students

KAN, Daisuke (D2)
YAMADA, Ikuya (D2)
HAYAMI, Arata (M2)
KANDA, Ryoko (M2)
YAMADE, Satoru (M2)

NODA, Akane (M1)
TAKATA, Kazuhide (M1)
TAKEDA, Yuhki (M1)
TSUJIMOTO, Yoshihiro (M1)

Visitor

Prof ETOURNEAU, Jean ICMCB-CNRS, France, 8 - 10 January 2004

Scope of Research

Novel inorganic materials and devices that have new, useful or exotic features such as superconductivity, ferromagnetism and quantum spin ground state are synthesized and fabricated by novel methods. For example:

- Oxides containing transition-metal ions in unusually high-valence state.
- Nonequilibrium materials that can be obtained by high pressure method or epitaxial thin film deposition method.
- Inorganic nanomaterials with useful functionality such as superparamagnetism and quantum size effect.

Research Activities (Year 2004)

Presentations

Fabrication and I-V Characteristics of pn Junctions Based on High T_C Superconductor Kan D, Terashima T, Shimakawa Y, Takano M, 11th International Workshop on Oxide Electronics, 3 - 5 October (Hakone).

Charge disproportionation of Ni(III) at the metal-insulator transition of RNiO$_3$ (R = Pr, Nd), SaitoT, Azuma M, Kanda H, Takano M, *et al.,* 4th International Conference on Inorganic Materials,19 - 21 September (Antwerp).

Current-induced first-order transition in the microfabricated perovskite manganese oxide thin films, Masuno A, Terashima T, Mikio T, 60th Annual Meeting, The Physical Society of Japan, 12 - 15 September (Aomori).

Synthesis, physical properties of $Ca_{2-x}CuO_2Cl_2$, Yamada I, Azuma M, Shimakawa Y, Takano M, 60th Annual Meeting, The Physical Society of Japan, 12 - 15 September (Aomori).

Light emission from oxygen deficient $SrTiO_3$, 93rd Annual Meeting, Japan Society of Powder and Powder Metallurgy, Kanda R, Kan D, Masuno A, Terashima T, Takano M, 25 - 27 May (Kyoto).

Grants

Takano M, Develeopment of 3d transition-metal oxides with oxygen holes, Grant-in-Aid for Scientific Research (A)(2), 1 April 2002 - 31 March 2005.

Terashima T, Electric field induced superconductivity in the FET devices using ultrathin $SrTiO_3$ single-crystal substrate with high dielectric constant, Grant-in-Aid for Scientific Research (B) (2), 1 April 2002 - 31 March 2004.

High Pressure Synthesis of Novel Cobalt Oxides and Their Magnetic and Transport Properties

We have found a novel cobalt oxide, $SrCo_6O_{11}$, by high pressure synthesis technique. As shown in figure 1, $SrCo_6O_{11}$ comprises Co_3O_8 Kagome layers with CoO_6 octahedra and CoO_5 bipyramids placed between them. Its spin system is geometrically frustrated, and has a strong spin-charge coupling, as seen in the sharp drop of the electrical resistivity when the spin structure is changed by external magnetic field. Such a spin-charge coupling via spin frustration has never been found so far, and is of keen interest. We are studying the detailed mechanism and the origin of the above physical properties, and are searching for new compounds with such a spin-charge coupling via spin frustration.

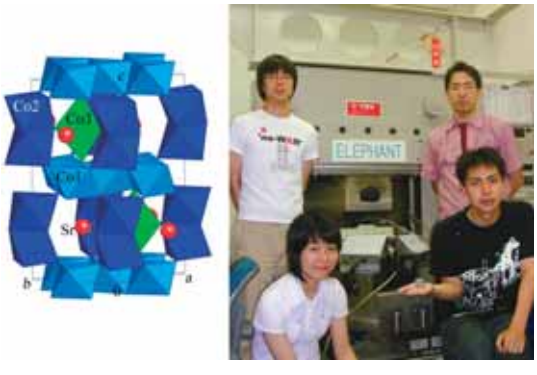

Figure 1. Crystal structure of $SrCo_6O_{11}$ and the high pressure synthesis apparatus.

Fabrication of Transition-metal Oxides p-(i)-n Heterojunctions by an Ion Beam Method

New type of heterojunctions comprising of $YBa_2Cu_3O_{7-\delta}$ (YBCO; p-type) and oxygen-deficient $SrTiO_3$ (STO; n-type) were fabricated by an Ar^+ ion beam method. Inset of Fig. 2 shows a schematical illustration of the junction: YBCO layer was grown on STO substrate by the pulsed laser deposition and a part of YBCO layer was etched by Ar^+ ion beam with a metal mask. n-type STO layer was generated by a slight reduction due to the relatively large sputtering rate of oxygen atoms in STO. Thus, p-(i)-n junction was formed at the interface between YBCO and STO layers. As shown in Fig. 2 the junction exhibits excellent rectifying current-voltage (I-V) characteristics, indicating that the method is of advantage for fabricating oxides p-(i)-n junctions. The interests of the junctions are a light emitting properties and a photovoltaic effect when the p and/or n layers are superconductive. Study for the junctions is now in progress.

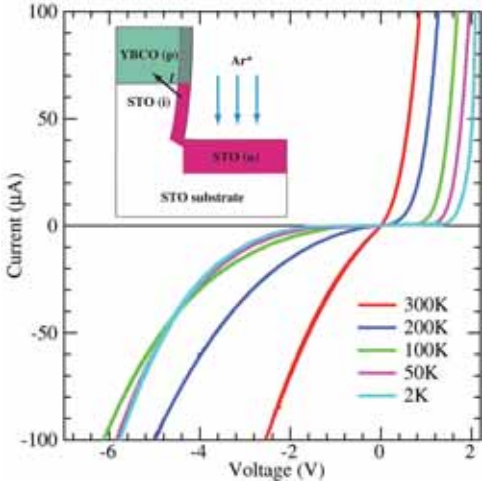

Figure 2. I-V characteristics for YBCO/STO p-i-n junction.

Synthesis of Monodisperse, Submicron-Sized Spherical V_2O_5 Particles

Monodisperse, submicron-sized spherical metal oxide particles attract much interest in many areas of science and technology. We have succeeded in synthesizing monodisperse, submicron-sized spherical V_2O_5 particles with narrow size distribution via hydrolysis of a vanadium isopropoxide for the first time. Transmission electron microscopic observations revealed that the formed particles had almost perfect spherical shape and were non-agglomerated. V_2O_5 particles are possibly used in catalysis, lithium ion battery, electrochromic device, sensors and actuators. The monodisperse spherical V_2O_5 particles obtained by our developed method will greatly improve the performance in such applications.

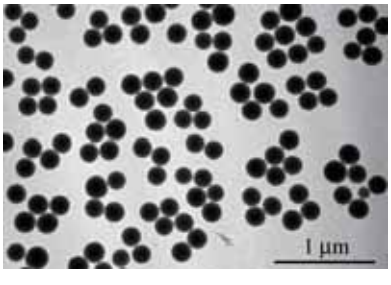

Figure 3. Transmission electron microscope image of V_2O_5 particles.